

Accordingly, at step 12 cutting loop 138 is redeployed out of the tissue channel by rotating cutting wire 136. Cutting wire 136 is energized during step 12, causing cutting loop 138 to make a first planar cut in the new tissue site. The tissue channel is then closed in step 13, and, in step 14, a second, cylindrical, proximal cut is made in the second tissue sample with cutting loop 138. The tissue channel is then opened in step 15, and vacuum, preferably high vacuum, is applied to main lumen 122, and the third, planar, proximal cut is made by rotating cutting wire 136 back into the proximal end of the open tissue channel in step 16. These cycles are repeated until cannula 102 has been rotated completely around axis 118, at which time sampling is complete, and cannula 102 can be withdrawn from the patient.

Yet another exemplary embodiment of a process for sampling tissue is similar to the “one-stroke” process described above, and includes fewer steps. The “one-stroke” process is performed up to the point where all three cuts have been made with cutting loop 138. Instead of closing the tissue channel, and thus enclosing cutting loop 138 in main lumen 122, the cutting loop 138 is immediately rotated back out of the main lumen before closing the tissue channel. The tissue channel is then closed and the tissue sample is retrieved, as described above, with cutting loop 138 outside of cannula 102. Cannula 102 is then rotated about axis 118, with cutting loop 138 energized, which causes cutting loop 138 to perform a first, planar, distal cut for a tissue sample from tissue adjacent to where the prior tissue sample had been taken. Second and third cuts are then performed in a manner similar to “one-stroke” process described above, except that cutting loop 138 is immediately rotated out of main lumen 122 after making the third, planar, proximal cut. Thus, several steps are eliminated from the “one-stroke” process, including opening and closing the tissue channel, which can lead to greater efficiency in the process.

Figure 15 illustrates a flow diagram of the “two-stroke” process, described above with reference to Table 1. The logic contained in the process described in

Figure 15 can be implemented in controlling vacuum source 108, motor driver 112, and RF generator 106 by a programmable logic controller (not illustrated), a general purpose digital computer in communication with a memory element containing computer readable instructions which embody the control logic (not illustrated),
5 application specific integrated circuit (ASIC) (not illustrated), or discrete digital signal processing (DDSP) (not illustrated).

At step 240, the process is initiated with patient preparation and equipment power-up sequences. At step 242, corresponding to step 1 in Table 1, cannula 102 is
10 inserted into the tissue to be sampled. A decision is made at step 244 whether or not cannula 102 is properly positioned: if it is not, the cannula is repositioned at step 246, and step 244 is performed again. If cannula 102 is properly positioned, the “door” or tissue channel is opened, step 2 in Table 1, and cutting loop 138 is deployed, step 3 in Table 1. A decision is made whether cutting loop 138 is deployed: if not, step 248 is
15 repeated. If cutting loop 138 is deployed, a longitudinal cut is performed at step 252, corresponding to step 5 in Table 1. A decision is then made whether the cut was completed: if not, step 252 is repeated; if the cut was completed, step 256 is performed. Step 256 corresponds to steps 6-9 in Table 1. After the wire has been reset in step 256, a decision is made at step 258 whether the sample has been received:
20 if not, step 256 is repeated until the sample has been properly received. A decision is then made at step 260 whether sampling is complete: if not, the inner and outer cannulae are rotated relative to one another to close the “door” or tissue channel at step 264, and the process returns to step 248. If tissue sampling is complete, cannula 102 is removed from the patient in step 262, and post-procedure bandaging and tissue
25 retrieval from tissue collector 114 is performed.

Figure 16 illustrates a flow diagram of the “one-stroke” process, described above with reference to Table 2. Several of the steps of the process described in Figure 16 are the same as those in the process described with reference to Figure 15

and Table 1, and therefore will not be further described. The logic contained in the process described in Figure 16 can be implemented in controlling vacuum source 108, motor driver 112, and RF generator 106 by a programmable logic controller (not illustrated), a general purpose digital computer in communication with a memory
5 element containing computer readable instructions which embody the control logic (not illustrated), application specific integrated circuit (ASIC) (not illustrated), or discrete digital signal processing (DDSP) (not illustrated).

In Figure 16, after the decision in step 254 is made that a complete
10 longitudinal cut has been made, the sample is retrieved, as described above with reference to Table 2. After performing steps 258, and if the decision is made that sampling is not complete, step 264 is performed, and step 252 is repeated. As described above with reference to Table 2, the cut performed in step 252 is a longitudinal cut after cannula 102 has been rotated into a new volume of tissue. If
15 sampling is complete after step 260, step 272 is performed, in which the status of the tissue channel or "door" is verified to be open, cutting loop 138 is rotated back into main lumen 122, and cannula 102 is removed from the patient.

Figure 17 illustrates a cutting pattern achieved by a system 100. In Figure 17,
20 a plurality of cylindrical cuts 280a-h are made by cannula 102 having a cutting loop 138 (not illustrated in Figure 17). As illustrated in Figure 17, while system 100 retrieves a plurality of samples, small areas 281 are left unsampled, because cutting loop 138 is generally circular. Cutting loops 176, 182, and 186 are specifically configured to extend cylindrical cuts 280 into these areas. For example, Figure 18
25 illustrates a distal end view of cannula 102 including cutting loop 176 or 182, which includes portion 180 which closely conforms to the external diameter of cannula 102. Thus, cutting loop 176 or 182 extends into areas 281 when longitudinal cuts are performed, which samples tissue closer to the center of the tissue mass of interest, as illustrated in Figure 19. Alternatively, cannula 102 can merely be rotated around axis